Incidence of the 1996 Canada–U.S. Softwood Lumber Agreement and the Optimal Export Tax

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Our partial-equilibrium analysis suggests 63% of the Canada–U.S. Softwood Lumber Agreement's export tax is absorbed by Canadian consumers. Still, sufficient surplus was extracted from U.S. consumers for the agreement to be in Canada's national interest. In fact, the agreement was suboptimal from a Canadian perspective in that a higher tax rate would have raised national welfare, at least in the short run. Although the agreement decreased U.S. welfare, the net loss for the combined U.S. and Canadian economies is modest, about 5% of the bilateral softwood lumber trade value according to our baseline estimates. This suggests the agreement's tariff rate quota scheme is a reasonably efficient mechanism for redistributing economic surplus from U.S. consumers to producers. Still, a better policy may be to enlarge the softwood lumber market via a research and promotion program funded by a modest (say, 5%) tax on Canadian exports.

L'analyse de l'équilibre partiel effectuée par les auteurs laisse croire que les consommateurs canadiens absorbent 63 % de la taxe à l'exportation de l'Accord. Néanmoins, le Canada a réussi à tirer une somme suffisante des consommateurs américains pour que l'Accord garde un intérêt national. De fait, pour le Canada, l'Accord n'était pas vraiment optimal, car un taux d'imposition inférieur aurait relevé le taux de prestations d'aide sociale, à court terme du moins. Bien que l'Accord ait réduit ce taux aux États-Unis, la perte nette demeure modeste pour l'économie combinée des deux pays (environ 5 % de la valeur commerciale du bois d'œuvre résineux selon les estimations des auteurs). On en conclut que les contingents tarifaires constituent un mécanisme raisonnablement efficace pour redistribuer les richesses excédentaires des consommateurs aux producteurs. Une meilleure politique consisterait cependant à élargir le marché du bois d'œuvre résineux au moyen d'un programme de recherche et de promotion que financerait une légère taxe (par exemple 5 %) sur les exportations canadiennes.

INTRODUCTION

The softwood lumber trade dispute between Canada and the United States is generally recognized as one of the most enduring and contentious between the two countries (Cashore 1997). An irony of this conflict is that Canada has consistently resisted U.S. proposals that are in its national interest. Specifically, as a large nation exporter of softwood lumber, Canada is in the position to extract rent from U.S. consumers via the imposition of an export tax (Enke 1944; Just, Schmitz and Zilberman 1979). Ordinarily, one might think that the United States would oppose such a tax. In fact, thanks to the strength of U.S. softwood industry lobby, the opposite is true.[1]

The puzzle then is why Canada continues to eschew the potential benefits of an export tax. One reason may be that such benefits have not been clearly delineated. For example, Myneni, Dorfman and Ames's (1994) analysis of the 1987–91 lumber agreement indicates a positive effect overall, as predicted by optimal tariff theory. However, no estimates are provided to indicate how the welfare benefits are distributed among Canadian consumers, producers and the treasury. Zhang's (2001) analysis of the 1996–2001 lumber agreement provides a measure of producer and treasury impacts, but Canadian consumer impacts are ignored.

The purpose of this research is to determine the incidence of the 1996 Canada–U.S. Softwood Lumber Agreement (SLA). The analysis differs from previous studies in that Canadian exports to non-U.S. markets are explicitly taken into account, as are "free-rider" effects associated with the exemption of certain classes of Canadian producers from the export restrictions.[2] As a by-product of our analysis, we identify the optimal export tax, which permits an assessment of whether the SLA's tax rate is too high or low.

The paper begins with a graphical analysis of the SLA's effects on Canadian and U.S. prices. We then develop a model to indicate tax incidence and to estimate welfare effects in the Canadian economy. The paper concludes with a summary of the key findings and a policy recommendation.

GRAPHICAL ANALYSIS

The SLA differs from prior trade policy (see Government of British Columbia 2001 for an historical overview) in that an export quota is the primary mechanism used to raise prices in the U.S. market. Specifically, rather than imposing a tax on all units of lumber exported to the United States, as in prior policy, the SLA establishes a "fee-free" export quantity Q_F, below which no tax is paid and beyond which a two-tier tax is applied (see Zhang 2001 for details). The policy is enforced by assigning quota (the sum of which equals Q_F) to lumber exporters on a pro rata basis. Importantly, the policy permits free riding, in that producers outside the major lumber-producing provinces of British Columbia, Alberta, Ontario and Québec are not subject to the export restrictions, nor are "small" producers within these provinces whose annual production is less than 10 million board feet. This scheme is a variation on the tariff rate quota (TRQ) policy that affects trade in *inter alia* dairy products (see, e.g., Larivière and Meilke 1999). A TRQ differs fundamentally from a simple export tax in that it generates quota rents, which means that domestic producers can capture benefits that would otherwise accrue to the treasury.[3]

A simplified depiction of how the policy works in a partial-equilibrium setting is provided in Figure 1. In this diagram, we abstract from the policy's targeted nature (exports to non-U.S. markets are not subject to the TRQ) and the fact that free riding affects the slope of the excess supply curve (both of these features are taken into account in the structural model to follow). Implicit in Figure 1 is the assumption that softwood lumber prices are determined under competitive conditions, a maintained hypothesis in this study.[4] In addition, we assume that supply and demand curves are linear in the relevant region. Welfare analysis based on the linearity assumption has its limitations. However, if the policy in question causes curves to shift in a parallel fashion, the linear model provides a good approximation regardless of the supply and demand curves' true functional forms (Alston, Norton and Pardey 1995, 58–62).

The intersection of the excess supply and demand curves *ES* and *ED* in Panel B gives the free market equilibrium price P^o. At this price Canada produces Q_S units of lumber, con-

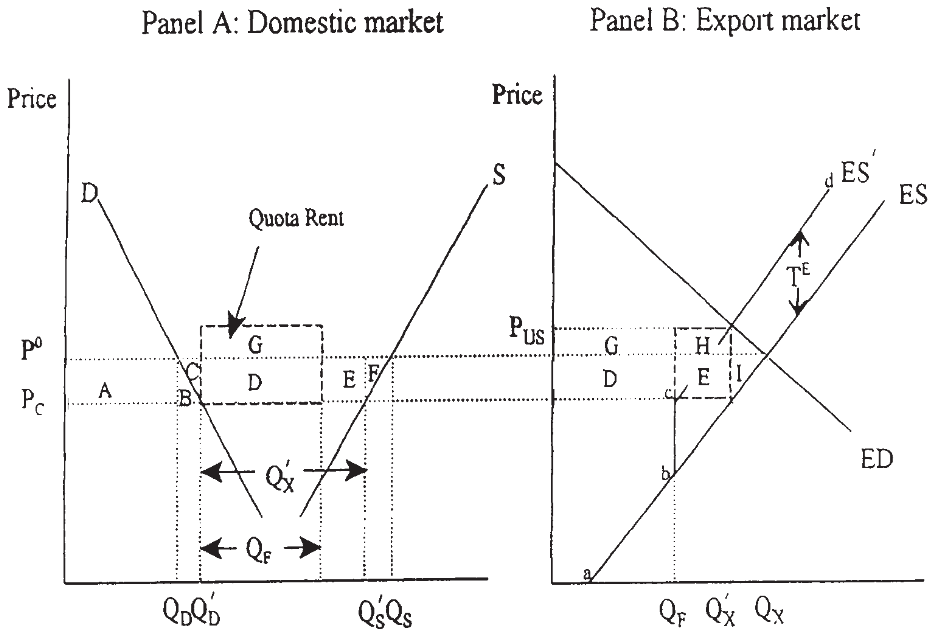

Figure 1. The Canada–U.S. Softwood Lumber Agreement 's effects on Canadian and U.S. lumber price

sumes Q_D units and exports Q_X units. The imposition of the SLA results in the kinked excess supply curve *abcd*, hereafter referred to as *ES*′.[5] The kink's location along the original excess supply curve *ES* is determined by the fee-free limit Q_F; its vertical length *bc* is determined by the **effective** per-unit tax T^E (to be defined later).

Depending on where *ED* intersects *ES*′, the TRQ scheme has three possible economic impacts in this isolated market context:

- If export demand is weak such that *ED* cuts *ES*′ along its lower segment *ab*, the policy has no effect, as market prices and quantities are unaffected.
- If export demand is moderate such that *ED* cuts *ES*′ along its vertical segment *bc*, the policy generates quota rents equal to Q_F times the difference between the export and domestic price.
- If export demand is strong such that *ED* cuts *ES*′ along its upper segment *cd*, in addition to quota rents equal to $Q_F \cdot T^E$, the policy generates treasury benefits equal $(Q_X{}' - Q_F)\, T^E$.

Because tax collections in all years were positive (Zhang 2001, Table 5), the third scenario above serves as the basis for the remaining analysis.

The tax collected under the third scenario places a wedge between the Canadian domestic price P_C and the export price P_{US} equal to T^E. Since $P_{US} > P^o$, U.S. producers benefit from the scheme at the expense of U.S. consumers. Similarly, since $P_C < P^o$, Canadian consumers benefit at the **possible** expense of Canadian producers. Specifically, referring to Figure 1, the gains and losses in the Canadian economy due to the SLA may be summarized as follows:

- consumer gain due to lower domestic price = $A + B$
- producer loss due to lower domestic price = $A + B + C + D + E + F$

- producer gain due to quota rent and free-rider benefits = $D + G$
- net producer impact = $G - (A + B + C + E + F)$
- treasury benefits = $E + H$
- deadweight and efficiency loss = $C + F = I$
- net effect on total economy = $1 + 4 + 5 = G + H - I$.

From the fourth item above, Canadian producers may gain or lose, depending on the relative size of rectangle G. This rectangle represents the portion of quota rents and free-rider benefits extracted from U.S. consumers.[6] A necessary (but not sufficient) condition for the SLA to be in Canada's national interest is a downward-sloping ED, the essence of Enke's (1944) argument.

MODEL

To clarify these effects and to provide a basis for measuring incidence, consider the following structural model for Canadian lumber:

$$Q_D = D(P_C) \quad \text{(domestic demand)} \tag{1}$$

$$M_{US} = M_{US}(P_{US}) \quad \text{(U.S. import demand)} \tag{2}$$

$$M_R = M_R(P_C) \quad \text{(ROW import demand)} \tag{3}$$

$$P_{US} = P_C \cdot T_{US} \quad \text{(U.S. price)} \tag{4}$$

$$Q_{SE} = S_E(P_{US}) \quad \text{(exempt producer supply)} \tag{5}$$

$$Q_{SN} = S_N(P_C) \quad \text{(nonexempt producer supply)} \tag{6}$$

$$Q_S = Q_{SE} + Q_{SN} \quad \text{(total Canadian supply)} \tag{7}$$

$$Q_S = Q_D + M_{US} + M_R \quad \text{(market clearing)} \tag{8}$$

where the variables are as defined in Table 1. In this model, since it is the above-quota export tax that constrains the equilibrium in the third type of economic impact described above, the TRQ quota does not enter into the algebraic determination of equilibrium. Rather, equilibrium is determined by the effective rate of τ_E (= T^E/P_{US}), which is modeled in Eq. 4 as the tax wedge $T_{US} = (1 + \tau_E)$. Exempt producers respond to P_{US}, which is higher than P_C, the price received by nonexempt producers. Hence, exempt producers receive an implicit subsidy from the SLA, which tends to undermine its effectiveness from the U.S. producer perspective.

The model contains eight endogenous variables (P_{US}, P_C, Q_D, Q_{SE}, Q_{SN}, Q_S, M_{US} and M_R) and one exogenous variable (T_{US}). We implicitly assume that softwood lumber is strictly separable from all other goods, at least as a first approximation. Exogenous variables that affect supply and demand other than the tariff are suppressed.

The key issue from the Canadian perspective is tax absorption. To determine that, we first express the model in percentage changes:

$$Q_D^* = \eta_C \, P_C^* \tag{1'}$$

Table 1. Baseline data and parameters, Canadian lumber industry, 1996–2000[a]

Item	Definition	Value
P_{US}	U.S. price of lumber (1997 \$/tbf)	425
Q_S	Canada's production of softwood lumber (bbf)	112
Q_D	Canada's consumption (bbf)[b]	30
M_{US}	U.S. imports from Canada (bbf)	72
M_R	ROW imports from Canada (bbf)	10
Q_X	Canada's total exports (= $M_{US} + M_R$)	82
Q_F	Fee-free exports (bbf)[c]	59
η_C	Domestic demand elasticity (absolute value)[d]	0.17
$\acute{\eta}_{US}$	U.S. import demand elasticity for Canadian lumber (absolute value)[d]	1.28
$\acute{\eta}_R$	ROW import demand elasticity for Canadian lumber (absolute value)[d]	1.45
$\in_{CE} = \in_{CN} = \in_C$	Domestic supply elasticity[d]	0.40
$\acute{\varepsilon}_{US}$	Canada's export supply elasticity to U.S.[c]	0.90
κ_C	Domestic quantity share (= Q_D/Q_S)	0.27
κ_{US}	U.S. quantity share (= M_{US}/Q_S)	0.64
κ_R	ROW quantity share (= M_R/Q_S)	0.09
κ_{US}'	U.S. export share (= M_{US}/Q_X)	0.88
κ_R'	ROW export share (= M_R/Q_X)	0.12
k	Proportion of Canada's lumber production covered by the SLA	0.85
ζ	Free rider parameter (= $(1 - k) \in_{CE} / \kappa_{US}$)[d]	0.094

[a]1 April 1996 through 31 March 2000. Price and quantity data were obtained from Canadian Forest Service.
[b]Includes 1 bbf from imports.
[c]Zhang (2001), Tables 1, 2 and 5.
[d]See text for details.

$$M_{US}^* = \acute{\eta}_{US} P_{US}^* \tag{2'}$$

$$M_R^* = \acute{\eta}_R P_C^* \tag{3'}$$

$$P_{US}^* = P_C^* + T_{US}^* \tag{4'}$$

$$Q_{SE}^* = \in_{CE} P_{US}^* \tag{5'}$$

$$Q_{SN}^* = \in_{CN} P_C^* \tag{6'}$$

$$Q_S^* = k\, Q_{SN}^* + (1 - k)\, Q_{SE}^* \tag{7'}$$

$$Q_S^* = \kappa_C Q_D^* + \kappa_{US} M_{US}^* + \kappa_R M_R^* \tag{8'}$$

where the symbol * refers to relative change (e.g., $P_C^* = dP_C/P_C$) and parameters are as defined in Table 1. In this formulation all parameters are assumed to be positive; specifically, the domestic and import demand curves are downward-sloping ($-\eta_C < 0$ and $\acute{\eta}_j < 0$ for $j = R, US$) and the domestic supply curves are upward-sloping ($\in_{CN} > 0$ and $\in_{CE} > 0$).

Next we derive Canada's supply curve for exports to the U.S. For this purpose, we delete Eq. 2. (since we want to treat P_{US} as temporarily exogenous) and solve the remaining equations simultaneously to yield:

$$M_{US}^* = \acute{\varepsilon}_{US}\, P_{US}^* - (\acute{\varepsilon}_{US} - \zeta)\, T_{US}^* \tag{9}$$

where:

$$\acute{\varepsilon}_{US} = (\in_C + \kappa_C\, \eta_C + \kappa_R\, \acute{\eta}_R)/\kappa_{US} \tag{9a}$$

$$\in_C = k \in_{CN} + (1 - k)\in_{CE} \tag{9b}$$

$$\zeta = (1 - k) \in_{CE}/\kappa_{US} \tag{9c}$$

For normal parameter values Canada's export supply curve to the U.S. is upward sloping ($\acute{\varepsilon}_{US} > 0$) and an increase in the export tax shifts the curve to the left ($-(\acute{\varepsilon}_{US} - \zeta) < 0$), as expected. From Eq. 9a, the export supply curve becomes more elastic as:

- Canadian producers or consumers become more sensitive to price (larger $\in_C$ or η_C)
- ROW importers become more sensitive to the price of Canadian lumber (larger $\acute{\eta}_R$)
- the U.S. becomes less important as a market outlet for Canadian lumber (smaller κ_{US}).

Free riding softens the policy's negative effect on export supply to the U.S., as the $\zeta(>0)$ term in Eq. 9 vanishes when $k = 1$.

Setting Eq. 9 equal to Eq. 2′ and reusing Eq. 4′ yields:

$$P_C^* = -\Omega_C\, T_{US}^* \tag{10}$$

where:

$$\Omega_C = (\acute{\eta}_{US} + \zeta)/(\acute{\eta}_{US} + \acute{\varepsilon}_{US}) \tag{10a}$$

is the desired "absorption," or Canadian tax incidence, parameter. For normal parameter values $\Omega_C < 1$, which means a rise in the export tax is partially absorbed by Canadian consumers. Absorption increases as Canada's supply to the U.S. becomes less elastic in relation to demand (smaller $\acute{\varepsilon}_{US}$ relative to $\acute{\eta}_{US}$) and as free riding increases (larger ζ). If $k = 1$ (10a) reduces to:

$$\Omega_C' = \acute{\eta}_{US}/(\acute{\eta}_{US} + \acute{\varepsilon}_{US}) \tag{10b}$$

which is the familiar tax incidence relation. Since $\Omega_C > \Omega_C'$ the exemption feature works to the disadvantage of U.S. producers. That is, the rise in the U.S. price associated with the policy is less than would be the case if the exemption feature did not exist. This result is intuitive, since exempt producers have an incentive to enlarge production to take advantage of the higher price available in the U.S. market. Overall, the SLA is most favorable from Canada's national welfare perspective when $\acute{\varepsilon}_{US}$ is large in relation to $\acute{\eta}_{US}$ as then most of the export tax's burden is borne by U.S. consumers.

MEASURING INCIDENCE AND THE FREE-RIDER EFFECT

To obtain numerical estimates of Ω_C, we rely on Zhang's (2001) analysis. In that study, a review of the literature identified the following "most likely" elasticity values: $\acute{\varepsilon}_{US} = 0.90$, $\in_{US} = 0.40$ and $\eta_{US} = 0.17$ where the latter two refer to domestic supply and demand elasticities in the U.S. The relationship between these parameters and $\acute{\eta}_{US}$ is as follows (Houck 1986, 34):

$$\acute{\eta}_{US} = (Q_S^{US}/M_{US}) \in_{US} + (Q_D^{US}/M_{US})\, \eta_{US} \tag{11}$$

where Q_S^{US} is U.S. lumber production, Q_D^{US} is U.S. lumber consumption, M_{US} is U.S. lumber imports from Canada. Inserting elasticity and average quantity values for the 1996–2000 period (Canadian Forest Service 2001) into Eq. 11 yields:

$$\acute{\eta}_{US} = (141/72)\ 0.40 + (209/72)\ 0.17 = 1.28$$

where the numbers in parentheses refer to billion board feet (bbf). Thus, the implied import demand curve is elastic at $\acute{\eta}_{US} = 1.28$, as might be expected, since Canada is not the U.S.'s sole supply source. Based on the foregoing, we adopt $\acute{\varepsilon}_{US} = 0.90$ and $\acute{\eta}_{US} = 1.28$ as these parameters "best bet" values.

Inserting $\acute{\varepsilon}_{US} = 0.90$ and $\acute{\eta}_{US} = 1.28$ into Eq. 10b yields $\Omega_C' = 0.59$, which means that Canadian producers bear 59% of the export tax *sans* free riding. By way of comparison, Myneni, Dorfman and Ames's (1994, 267) welfare estimates imply that Canada's producers bear 91% of the export tax. The discrepancy arises because in Myneni, Dorfman and Ames's study the excess supply elasticity is set to $\acute{\varepsilon}_{US} = 0.19$, the value estimated from their econometric model. This implies that the *ES* curve in Figure 1 is highly inelastic. Although this may be true in the short run (say, one year or less), in the longer run one would expect Canada's excess supply curve to be relatively elastic, as $\acute{\varepsilon}_{US}$ reflects price responses of producers and consumers in the domestic (Canadian) market as well as price responses by non-U.S. foreign customers (see Eq. 9a). In fact, the domestic supply elasticity sets the lower bound on the excess supply elasticity, i.e., $\acute{\varepsilon}_{US} \geq \in_C$, where the strict equality holds when domestic consumption is zero and all exports go to the U.S. If it is reasonable to assume that $\in_C \approx \in_{US} = 0.40$, then Myneni, Dorfman and Ames's estimate of $\acute{\varepsilon}_{US}$ is downward biased. Indeed, in their sensitivity analysis Boyd and Krutilla (1987) assumed that $\acute{\varepsilon}_{US} \in [0.45, 1.35]$, which contains Zhang's $\acute{\varepsilon}_{US} = 0.90$ as a centering value. Thus, the estimate of $\Omega_C' = 0.59$ based on Zhang's elasticities appears reasonable **neglecting free-rider effects**.

To take free riding into account, an estimate of ζ is needed. For this purpose, we set $k = 0.85$ and $\kappa_{US} = 0.64$, the average values for these parameters over the evaluation period (Table 1). In addition, we set $\in_{CE} = \in_{US} = 0.40$ under the maintained hypothesis that supply responses in Canada and U.S. are similar, as are supply responses between exempt and nonexempt producers. Inserting these values in Eq. 9c yields $\zeta = 0.094$. Substituting this value along with $\acute{\varepsilon}_{US} = 0.90$ and $\acute{\eta}_{US} = 1.28$ into Eq. 10a yields $\Omega_C = 0.63$, which is slightly higher than $\Omega_C' = 0.59$. Hence, the free-rider effect appears to be modest, raising Canadian incidence about 7%.

WELFARE EFFECTS

The analysis thus far suggests that 37% of the export tax is borne by U.S. consumers. At issue is whether this degree of tax shifting suffices for the SLA to be in Canada's national interest.

To determine that and to estimate the policy's distributional impacts, the following formulas are developed (see Appendix A):

$$CG_C = -P^o\, Q_D\, [P_C^*/T_{US}^*]\, T_{US}^*\, (1 + {}^1/_2\, [Q_D^*/T_{US}^*]\, T_{US}^*\,) \tag{12a}$$

$$CL_{US} = P^o\, Qx\, [P_{US}^*/T_{US}^*]\, T_{US}^*\, (1 + [Q_X^*/T_{US}^*]\, T_{US}^*\,) \tag{12b}$$

$$DWL_C = {}^1/_2\, P^o\, Q_X\, [P_C^*/T_{US}^*]\, T_{US}^*\, [Q_X^*/T_{US}^*]\, T_{US}^* \tag{12c}$$

$$EWG_C = CL_{US} - DWL_C \tag{12d}$$

where:
CG_C = the welfare gain to Canadian consumers
CL_{US} = the portion of the policy's cost borne by U.S. consumers (= rectangle $G + H$ in Figure 1)
DWL_C = the policy's deadweight/efficiency loss in the Canadian economy (= triangle I)
EWG_C = the economy-wide gain (= $G + H - I$).[7]
In these formulas, the bracketed terms are reduced-form elasticities, and $Q_X = M_{US} + M_R$, which implies:

$$Q_X^* = \kappa_{US}'\, M_{US}^* + \kappa_R'\, M_R^* \tag{12e}$$

where κ_{US}' and κ_R' are export shares (see Table 1).

Producer impacts in Canada are calculated as a residual using the identity:

$$PG_C = EWG_C - CG_C - TG_C \tag{12f}$$

where the treasury gain, TG_C, is taken from Zhang's (2001) analysis. From Eq. 12f, for Canadian producers to gain from the SLA, the rent extracted from U.S. consumers must be sufficiently large to cover Canadian consumer and treasury gains and still leave something left over for quota rents.

The reduced-form elasticities specified in Eq. 12 are derived from the model as follows:

$$P_C^* = -\Omega_C\, T_{US}^* \tag{13a}$$

$$P_{US}^* = (1 - \Omega_C)\, T_{US}^* \tag{13b}$$

$$Q_D^* = \Omega_C\, \eta_C\, T_{US}^* \tag{13c}$$

$$M_{US}^* = -\,(1 - \Omega_C)\, \acute{\eta}_{US}\, T_{US}^* \tag{13d}$$

$$M_R^* = \Omega_C\, \acute{\eta}_R\, T_{US}^* \tag{13e}$$

Numerical values for Eqs. 13a and 13e are obtained by setting $\Omega_C = 0.63$, $\eta_C = 0.17$ and $\acute{\eta}_R = 1.45$ in the baseline simulations. The $\Omega_C = 0.63$ is based on $\zeta = 0.094$, $\acute{\varepsilon}_{US} = 0.90$ and $\acute{\eta}_{US} = 1.28$, the "best bet" values for these parameters. The value $\acute{\eta}_R = 1.45$ is obtained using

Eq. 9a with $\acute{\varepsilon}_{US} = 0.90$ and κ_i and $\in_C$ set to the baseline values given in Table 1. The Eq. 13 set coupled with Eq. 12e constitutes the information needed to compute numerical values for bracketed terms in Eqs. 12 a–12c. It remains to quantify $T_{US}*$.

Effective Tax Rate

To quantify the tax wedge, note that by definition $T_{US}* = d\tau_E/(1 + \tau_E)$, which implies $T_{US}* = \tau_E$, since the initial (pre-SLA) tax rate is zero. Hence, the problem reduces to determining the value for τ_E. As shown in Appendix B, the effective **per-unit** tax under plausible assumptions is bounded on the closed interval $T^E \in$ [\$100, \$200]. Recalling that $\tau_E = T^E/P_{US}$ and setting P_{US} = \$425 (the average U.S. price over the evaluation period) implies that $\tau_E \in [0.23, 0.47]$. Taking the interval's midpoint as τ_E's "best bet" value implies $T_{US}* = 0.35$, the value used for this variable in the remainder of the analysis.

Setting $\tau_E = 0.35$ implies a tax wedge of \$110 (see Eq. 4), \$41 of which comes from U.S. consumers and \$69 from Canadian producers (given $\Omega_C = 0.63$).[8] Setting P_{US} = \$425, the implied free market price is P^o = \$384, the baseline value for this variable in Eqs. 12a–12c. The corresponding values for Q_D and Q_X are given in Table 1.

Results

Results for baseline parameters suggest the SLA's net effect on Canada's economy is positive (Table 2). Specifically, the gain from tax shifting (the share of the SLA's cost borne by U.S. consumers) for the 1996–2000 period is \$3.64 billion. This gain is sufficient to offset the deadweight/efficiency loss of \$0.37 billion due to the trade distortion and yield a net economy-wide benefit of \$3.26 billion. The economy-wide benefit is distributed as follows: \$2.59 billion for consumers, \$0.23 billion for the treasury and \$0.45 billion for producers. Thus, in this baseline simulation, the SLA's effect on all stakeholder groups is positive, with Canadian consumers being the major beneficiary.

Sensitivity analysis is performed by varying $\acute{\varepsilon}_{US}$ and $\acute{\eta}_{US}$ as indicated in Table 2 with η_C, $\acute{\eta}_R$ and ζ held constant at baseline values. Focusing first on the excess supply elasticity, we set $\acute{\varepsilon}_{US}$ alternatively to 0.45 and 1.35, the extreme values for this parameter used by Boyd and Krutilla (1987) in their sensitivity analysis. With the maintained hypothesis that $P^o = 384$ and $\acute{\eta}_{US} = 1.28$, results show the economy-wide impact increasing (decreasing) as export supply becomes more (less) elastic, but in all cases the impact remains positive. The same is true for the consumer impact, which decreases from \$3.28 billion to \$2.14 billion as $\acute{\varepsilon}_{US}$ is increases from 0.45 to 1.35 (and more of the tax is absorbed by U.S. consumers). The producer impact, in contrast, switches sign. Specifically, the producer impact ranges from –\$1.46 billion to \$1.62 billion, with the negative impact occurring when export supply is inelastic at $\acute{\varepsilon}_{US} = 0.45$. In this instance, Canadian producers bear 79% of the export tax (compared with 52% when $\acute{\varepsilon}_{US} = 1.35$), which explains the negative impact. Thus, to the extent that $\acute{\varepsilon}_{US}$ is less elastic than the baseline value of 0.90, there is no assurance that the SLA benefited Canada's producers. In particular, the "breakeven" value for $\acute{\varepsilon}_{US}$ is 0.77 (assuming $\acute{\eta}_{US} = 1.28$), which means Canadian producers do not gain from the SLA unless $\acute{\varepsilon}_{US} > 0.77$.

Turning to the demand elasticity, $\acute{\eta}_{US}$ is reduced to $\acute{\eta}_{US} = 0.64$ and increased to $\acute{\eta}_{US} = 1.92$, the same percentage range considered for $\acute{\varepsilon}_{US}$. Results are similar in that the economy-wide and consumer effects remain positive, but the producer impact switches sign (Table 2, right half). In particular, holding $\acute{\varepsilon}_{US}$ constant at 0.90, the producer impact ranges from

Table 2. Effect of 35% tax on Canadian softwood lumber exports to the Unite States on Canadian welfare, 1996–2000 (in billions of 1997 U.S. dollars)

	$\acute{\varepsilon}_{US}$[b]			$\acute{\eta}_{US}$[c]		
Item[a]	0.45	0.90	1.35	0.64	1.28	1.92
1 Gain from tax shifting (*G* + *H*)	2.19	3.64	4.44	5.34	3.64	2.75
2 Deadweight + efficiency loss (*I*)	0.14	0.37	0.45	0.19	0.37	0.49
3 Net economy-wide impact (1 – 2)	2.05	3.26	3.99	5.15	3.26	2.26
4 Consumer gain (*A* + *B*)	3.28	2.59	2.14	1.95	2.59	2.94
5 Treasury gain	0.23	0.23	0.23	0.23	0.23	0.23
6 Producer impact (3 – 4 – 5)	–1.46	0.45	1.62	2.97	0.45	–0.91

[a]Refer to Figure 1 for areas being measured and text for equations.
[b]Holds $\acute{\eta}_{US}$ constant at 1.28.
[c]Holds $\acute{\varepsilon}_{US}$ constant 0.90.

–\$0.91 billion to \$2.97 billion, with the negative impacts occurring when export demand is elastic at $\acute{\eta}_{US} = 1.92$. This result is intuitive, as Canadian producers absorb more of the tax increase as export demand becomes more elastic *ceteris paribus*. In particular, $\Omega_C = 0.71$,when $\acute{\eta}_{US} = 1.92$, compared with $\Omega_C = 0.48$ when $\acute{\eta}_{US} = 0.64$. Thus, to the extent that $\acute{\eta}_{US} \in [0.64, 1.92]$ and $\acute{\varepsilon}_{US} \in [0.45, 1.35]$ reflect true confidence intervals, Canadian producer impacts must be regarded as uncertain. In view of this uncertainty, it is not surprising that some Canadian producers opposed continuation of the agreement when it expired in April 2001.

Combined Canadian and U.S. Impacts

By way of summary, in Table 3, we combine Zhang's (2001) estimates of the U.S. impact with our estimates of the Canadian impact. These estimates are based on the maintained hypothesis that $\acute{\varepsilon}_{US} = 0.90$, $\acute{\eta}_{US} = 1.28$, $\zeta = 0.094$ and $\tau_E = 0.35$. With these assumptions and the aforementioned caveats, producers in the U.S. and Canada benefited from the agreement at the expense of U.S. consumers. Thus, in Myneni, Dorfman and Ames's terminology, the SLA represents "beggar thy consumer" trade policy from the U.S. perspective. As well, Canada's overall economy benefits, but at the expense of the U.S. economy (net effect for the two economies is –\$1.48 billion). Thus, from the Canadian perspective the SLA may be characterized as "beggar thy neighbor" trade policy, although in fairness the policy was implemented under pressure from the U.S.

For the two countries combined, at the margin, the SLA generates \$8.19 in producer surplus for \$9.89 lost in consumer surplus, i.e., $\Delta PS/\Delta CS = 0.83$. In Gardner's (1983) framework, a policy designed to benefit producers becomes more efficient as $dPS/dCS \rightarrow 1.00$ (the logic here is that if $dPS/dCS = 1.00$, the deadweight loss per dollar of consumer surplus transferred to producers at the margin is zero). Thus, if the goal is simply to benefit lumber producers, one might argue that the SLA is relatively efficient. According to these baseline estimates, the net loss to the two economies in terms of gross softwood lumber trade value is approximately 5%.

Table 3. The Canada–U.S. Softwood Lumber Agreement's impact on United States and Canadian economies, 1996–2000 (in billions of 1997 U.S. dollars)

Item	U.S.[a]	Canada	Both
Consumer surplus	–12.48	2.59	–9.89
Producer surplus	7.74	0.45	8.19
Treasury gain	0.00	0.23	0.23
Net effect	–4.74	3.26	–1.48
|Net effect| trade value[b]	0.15	0.11	0.05

[a]Taken from Zhang (2001, Table 5); Canadian impacts are from this study, Table 2.
[b]Trade value (= $31 billion in 1997 U.S. dollars) refers to gross earnings on Canadian exports to the United States as computed from Table 1.

OPTIMAL EXPORT TAX

The analysis so far suggests that the SLA's overall impact on Canada's economy was positive. This raises the question of whether an even larger benefit could have been achieved with a different tax rate. To answer this question, we use an expression for the optimal tax rate developed by Just, Schmitz and Zilberman (1979). In applying the expression to the present problem, several caveats need to be mentioned. First, the expression implicitly assumes that the taxed commodity has no important substitutes. In reality, softwood lumber competes with substitute building materials (e.g., steel and concrete) and may be differentiated by supply source. The failure to take into account substitution effects will tend to cause the optimal tax rate to be overstated. Moreover, the rule is static in that it does not take into account tax-induced development of new supply sources (e.g., in Brazil), which would tend to undercut the demand for Canadian lumber in the long run.[9]

With these caveats in mind, the expression for the optimal export tax is:

$$\tau^o = 1/e_D \tag{14}$$

where $\tau^o = T^o/P_{US}$ is the tax rate that maximizes Canadian national welfare. In this expression, e_D is the "total" excess demand elasticity defined as follows:

$$e_D = \kappa_{US}' \acute{\eta}_{US} + \kappa_R' \acute{\eta}_R$$

From Eq. 14, the optimal export tax rate is simply the reciprocal of the excess demand elasticity. By substituting numerical values into Eq. 14 for the indicated parameters, one can compare the optimal tax rate τ^o with the "observed" tax rate $\tau_E = 0.35$. For example, in the baseline case where $\acute{\eta}_{US} = 1.28$, $\acute{\eta}_R = 1.45$, $\kappa_{US}' = 0.88$ and $\kappa_R' = 0.12$, the excess demand elasticity is $e_D = 1.30$, which implies $\tau^o = 0.77$. Thus, to the extent that the baseline elasticities are reflective of their true values, it would appear that the SLA's effective tax rate is too low in the sense that a higher rate would increase Canada's national welfare.[10]

That this conclusion is contrary to popular press reports should not be surprising. As mentioned, Canada's producers have little to gain from an increase in the export tax *cum* quota and may actually lose, especially if the export supply elasticity for Canadian lumber is smaller than about $e_S = 0.77$ (recall Myneni, Dorfman and Ames's estimate of $e_S = 0.19$). Canada's consumers, on the other hand, have much to gain, for they pay less for lumber and benefit (along with Canada's producers) from the increased expenditures for public works or tax relief, financed in part by U.S. consumers. But caution is required in arguing for a higher tax rate, as substitution effects could weaken the market demand for softwood lumber in the long run, as noted earlier.

CONCLUDING COMMENTS

From a national welfare perspective, the United States and Canada each have an incentive to impose a tariff on softwood lumber, as both countries can exercise market power in the international market. Specifically, owing to its dominant position as a lumber importer, the United States can act as a monopsonist and discriminate against foreign producers via an import duty. The duty, properly set, generates economy-wide benefits from the U.S. perspective, since tax payments extracted from foreign producers exceed internal efficiency and deadweight losses (see, e.g., Enke 1944), leaving surplus funds for tax relief or public works. A parallel argument on the export side applies to Canada, as this study elucidates. There is an asymmetry, however, in that an import duty is protectionist, while an export tax is not. Thus, Canada is in a stronger bargaining position vis-à-vis the United States, as protectionism violates principles enunciated in the North American Free Trade Agreement.

Canada's problem is that an export tax, or its quota equivalent, may not be in domestic producers' interest, as this study shows. And since producers' interest trumps the national interest in the ongoing trade dispute, this uncertainty explains in part Canada's resistance to protectionist pressures from the United States. Still, if the choice is between acceding to U.S. demands for an export limit and an import duty imposed unilaterally by the United States, the export limit is clearly preferred, as an import duty harms Canada's producers, with no offset to the Canadian treasury or overall economy.

One possible solution to the dispute is for Canada to impose an export tax and use the proceeds to fund generic advertising and research that would strengthen the demand for softwood lumber in the North American market. This approach was taken by Norway in response to protectionist pressures from the European Union with respect to farmed salmon (see, e.g., Kinnucan and Myrland 2000, 2002). In addition to raising the U.S. price, such a scheme will raise the Canadian price, provided the advertising and research programs are sufficiently effective at expanding demand. U.S. consumers may be no better off under such a scheme, but they are not likely to be worse off, especially if the tax is set below the SLA effective rate of 35%. Of course, for this approach to be feasible, U.S. producers would need to be persuaded.[11]

A caveat in interpreting our results is that they are based on elasticity values taken from the literature, some of which are becoming dated. Of special concern is Canada's export supply elasticity for softwood lumber, as this parameter proved pivotal in determining whether the agreement's impact on Canada's producers was positive or negative. Clearly, econometric effort to update and refine elasticity estimates could have a large payoff in terms of improved policy design, especially if the goal is to minimize potential adverse effects on Canada's producers. In the meantime, given that the optimal export tax computed in this study is well above the rate specified in 1996 agreement, there seems little doubt that an export tax on softwood lumber is in Canada's national interest, albeit at the expense of U.S. consumers.

NOTES

[1]Under existing trade rules and given U.S. International Trade Commission's findings of domestic industry damage caused by subsidized imports, the United States could impose a countervailing duty. However, historically the U.S. has opted for a negotiated settlement, whereby Canada agrees to a "voluntary" export tax. In essence, the U.S. has been willing to forgo treasury revenue to avoid the appearance of protectionism, prevent retaliation and maintain friendly relations on international issues.

[2]A reviewer suggested that "free riding" lacks precision in the present context and recommended the term "preferential access" to describe exempt producers. Since the latter term is cumbersome, we continue to use the former, with the caveat noted.

[3]Quota "rent" refers to the extra value of lumber that accrues to sellers due to the trade restriction. It is akin to the "tariff equivalent revenue" discussed by Allen, Dodge and Schmitz (1983) in connection with voluntary export restraints. For a clear discussion of quota rents generated by TRQs, see Skully (1998).

[4]As noted by an anonymous Journal reviewer, there may be grounds to treat nonexempt Canadian producers as a Cournot oligopoly, a potentially fruitful extension of the present analysis. Also, the competitive industry assumption should not be confused with the government's ability to exercise monopoly power *à la* Enke (1944), which is properly interpreted to mean that Canada is a "large nation" exporter of softwood lumber and thus can influence market price when it acts as a collective unit.

[5]Technically, the ES' curve kinks twice under the SLA. However, the horizontal distance between the first and second kink is minuscule (less than 1% of exports). Hence, we follow Larivière and Meilke (1999) and draw Figure 1 with a single kink.

[6]In this study, per-unit free-rider benefits are defined as $P_{US} - P_C$. The logic is that producers not covered by the SLA can sell lumber into the U.S. market at the higher price without having to pay the export tax. In Figure 1, for simplicity, these benefits are included in the quota rent rectangle $G + D$.

[7]As noted earlier, Figure 1 does not explicitly include free-rider effects and the targeted nature of the export tax. However, free riding affects the magnitude of the shift in the ES curve (see Eq. 9) and the targeted nature of the tax affects the slope of the ES curve (see Eq. 9a), both of which are taken into account in the structural model used to compute the price and quantity impacts indicated in the diagrams.

[8]The $41 increase in the U.S. price implied by the present analysis is below Lindsey, Groombridge and Loungani's (2000) estimate of $50–80 and Zhang's (2001) estimate of $59. However, this is to be expected, as the present analysis takes into account free-rider effects, which erode the SLA's ability to increase the U.S. price. Also, Lindsey, Groombridge and Loungani's estimates are in nominal dollars, whereas the present estimates are in 1997 dollars; an inflation adjustment would further close the gap.

[9]For an insightful analysis of supply response in the context of cartel behavior, see Van Duyne (1975).

[10]A caveat in interpreting this result is that Eq. 14 is based on the implicit assumption that the tax is applied uniformly to all exports, which is not the case under the SLA. Still, the fact that the optimal rate is more than double the observed rate increases confidence that the observed rate is too low.

[11]The tax would have to be set high enough to assuage U.S. producer demands for protection, yet not so high as to defeat advertising and research's ability to offset the tax's depressing effect on the Canadian price. Based on these considerations and Kinnucan and Myrland's (2000) optimality conditions, a tax rate of 5% suggests itself. Since producers would gain control of the tax receipts, the quota scheme could be jettisoned, thus reducing transactions costs. A portion of the receipts could be remitted to government to cover administrative expenses.

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APPENDIX A: DERIVATION OF WELFARE FORMULAS

The formulas given in the text are derived by reference to Figure 1 under the assumption that supply and demand curves are linear in the relevant region. To illustrate the method, it is sufficient to derive the formula for consumer impact. Referring to Figure 1, let:

$$\begin{aligned}\Delta CG_C &= \text{area of rectangle A + triangle B}\\ &= (P^o - P_C)\, Q_D + 1/2\, (P^o - P_C)\, (Q_D{}' - Q_D)\\ &= (P^o - P_C)(Q_D + 1/2\, (Q_D{}' - Q_D))\end{aligned}$$

Factoring Q_D:

$$\Delta CG_C = (P^o - P_C)\, Q_D\, (1 + 1/2\, (Q_D' - Q_D)/Q_D)$$

Multiplying by $-P^o/P^o$:

$$\Delta CG_C = -\, P^o\, Q_D\, ((P_C - P^o)/P^o)\, (1 + 1/2\, (Q_D' - Q_D)/Q_D))$$

or, in text notion:

$$\Delta CG_C = -\, P^o\, Q_D\, P_C{}^*\, (1 + 1/2\, Q_D{}^*)$$

Multiplying asterisked terms by $T_{US}{}^*/T_{US}{}^*$ yields:

$$\Delta CG_C = -P^o\, Q_D\, [P_C{}^*/T_{US}{}^*]\, T_{US}{}^*\, (1 + 1/2\, [Q_D{}^*/T_{US}{}^*]\, T_{US}{}^*)$$

which is identical to the text equation for consumer gain. Remaining equations are derived in a similar fashion.

APPENDIX B: THEORETICAL LIMITS ON THE SLA'S MARGINAL TAX RATE

In this analysis, we assume that non-exempt producers form conjectures about how changes in their exports affect the fee-free limit, Q_F. Although this departs from the perfectly competitive assumption that underlies the structural model, it should not compromise the analysis provided the posited conjectures have no important effects on market price **in the long run**.

With the foregoing caveat, consider the non-exempt exporter's short-run profit function:

$$\pi\, P_{US}\, Q_{US} - C(Q_{US}) - T_1\, (Q_2 - Q_F) - T_2\, (Q_{US} - Q_2) \tag{B-1}$$

where:
$C(Q_{US})$ = exporter costs
T_1 = the per-unit tax applied on exports $Q_{US} \in [Q_F, Q_2]$
T_2 = the per-unit tax on exports $Q_{US} > Q_2$ where Q_2 is the upper TRQ limit.

Specifically, according to SLA rules, T_1 = \$50/tbf and T_2 = \$100/tbf in the agreement's first year, with inflation adjustments thereafter. In addition, a "trigger price" provision permits Q_F and Q_2 to be increased if the U.S. price exceeds prespecified levels (see Zhang 2001 for details). This provision is important because it provides an incentive for exporters to restrict exports, which in essence acts to increase the tax. From an analytical perspective, it implies that the limits are properly treated as endogenous. Eq. B-1 implicitly assumes that actual exports exceed the upper limit; i.e., $Q_{US} > Q_2$, as was generally true over the study period.

Interpreting Eq. B-1 as applying to a "representative" exporter who treats the U.S. price as given, the first-order condition is:

$$\partial\pi/\partial Q_{US} = P_{US} - \partial C/\partial Q_{US} - T_1\, (\partial Q_2/\partial Q_{US} - \partial Q_F/\partial Q_{US}) - T_2\, (1 - \partial Q_2/\partial Q_{US}) = 0$$

Noting that $\partial Q_2/\partial Q_{US} = \partial Q_F/\partial Q_{US}$, i.e., the upper and lower limits are increased by the same absolute amount if the trigger-price provision is binding, the above equation yields the equilibrium condition:

$$P_{US} = MC + T_2 (1 - \delta) \tag{B-2}$$

where $MC = \partial C/\partial Q_{US}$ is marginal cost and $\delta = \partial Q_F/\partial Q_{US}$ is a parameter that indicates the exporter's conjecture about how changes in its level of exports affect the fee-free limit Q_F. Since MC represents the firm's supply curve, the $T_2 (1 - \delta)$ term in Eq. B-2) may be interpreted as the vertical shift in that curve. The magnitude of the supply shift depends on T_2, but also on the conjecture parameter δ.

To sign δ, we write it in its expanded form as follows:

$$\delta = (\partial Q_F/\partial P_{US})(\partial P_{US}/\partial Q_{US})$$

where $\partial Q_F/\partial P_{US}$ indicates the effect of an increase in the U.S. price on the fee-free limit, and $\partial P_{US}/\partial Q_{US}$ indicates the effect of an increase in exports on the U.S. price **as perceived by the exporter**. Since $\partial Q_F/\partial P_{US} > 0$ by definition, and economic logic dictates that $\partial P_{US}/\partial Q_{US} \leq 0$, it follows that $\delta \leq 0$. Thus, $T^E = T_2 (1 - \delta) \geq T_2$, i.e., $T_2 = \$100$ sets the **lower** limit on the effective per-unit tax when Q_2 is binding. To establish an upper limit, we posit that $\delta \in [-1, 0]$, which implies that exporters believe that a one-unit decrease in their exports will increase the fee-free limit by **at most** one unit. If this assumption is valid, then $100 \leq T^E \leq 200$, i.e., the effective per-unit tax at the margin is bounded between \$100 and \$200.